

Table of Contents

Executive Summary i
Acknowledgments x
Table of Contents xi
List of Figures xiv
List of Tables xvi

Chapter 1.0 Introduction

1.1 Background 1-1
1.2 Objectives 1-2
1.3 Report Outline 1-3

Chapter 2.0 Disinfection By-Products

2.1 Disinfection 2-1
2.2 Formation of Disinfection By-Products (DBPs) 2-7
2.3 Chlorination By-Products and Health Effects 2-8
 2.3.1 Toxicology Studies 2-8
 2.3.2 Epidemiology Studies 2-10
2.4 Balancing Act 2-11
2.5 THM Guidelines 2-11

Chapter 3.0 Public Water Supplies and THM Monitoring Program

3.1 Characteristics of Public Water Supplies 3-1
3.2 THM Formation Potential 3-1
 3.2.1 Natural Factors 3-1
 3.2.2 Human Factors 3-4
 3.2.3 THM Formation Potential Ranking 3-4
3.3 Water Treatment Practices 3-6
 3.3.1 Chlorination 3-6
 3.3.2 Conventional Water Treatment Plants 3-8
 3.3.3 Non-conventional Water Treatment Practices 3-11

3.4	THM Monitoring Program in Newfoundland and Labrador	3-13
3.4.1	Sampling	3-14
3.4.2	Storage and Shipment	3-15
3.4.3	Laboratory Analysis of THM Samples	3-15
3.5	Monitoring Status	3-16
3.6	Data Management and Dissemination	3-16

Chapter 4.0 Data Analysis and Discussion

4.1	Simple and Seasonal Averages of THM Data	4-1
4.2	Seasonal Variation	4-10
4.3	Spatial Variation	4-14
4.4	Identification of Water Supplies for THM Control	4-18
4.5	THM Control Strategies	4-18

Chapter 5.0 Preventative/Mitigative Measures

5.1	Control Measures by Municipal and Provincial Governments (SCM)	5-1
5.1.1	Watershed Protection	5-2
5.1.2	Chlorine Demand Management	5-2
5.1.3	Removal of THM Precursors	5-4
5.1.4	Use of Alternative Disinfectants	5-5
5.1.5	Conventional Water Treatment	5-13
5.1.5.1	Disinfection	5-14
5.1.5.2	Coagulation/Filtration	5-14
5.1.5.3	Ion Exchange and Demineralization	5-16
5.1.5.4	Organic Removal	5-17
5.1.5.5	Lime Softening/Corrosion Control	5-17
5.1.6	Assessment of Alternative Water Supply Sources	5-18
5.2	Control Measures by Consumers (POE or POU)	5-18

Chapter 6.0	Future Direction	6-1
Chapter 7.0	Conclusions/Recommendations	
7.1	Conclusions	7-1
7.2	Recommendations	7-2
8.0	References	8-1

Appendices:

<u>Appendix A</u>	Communities with Surface Water Supplies in the Province	A-1
<u>Appendix B</u>	THM Formation Potential of Surface Water Supplies in the Province	B-1
<u>Appendix C</u>	Solicitation Letter for THM Monitoring Program (2000)	C-1
<u>Appendix D</u>	THM Sampling Protocol and Field Sheet	D-1
<u>Appendix E</u>	THM Database Forms and Community Report	E-1
<u>Appendix F</u>	THM Data Printout	F-1
<u>Appendix G</u>	Seasonal Data Gaps	G-1
<u>Appendix H</u>	Summary of THM Data	H-1
<u>Appendix I</u>	THM Data (Bromoform and Dibromochloromethane)	I-1
<u>Appendix J</u>	Development of THM Guidelines	J-1

List of Figures

Figure 2.1: Factors Affecting Chlorine Efficiency 2-6

Figure 2.2: The Chemical Structure of each of the four forms of THMs 2-9

Figure 3.1: Sources of Public Water Supply Systems in Newfoundland and Labrador 3-2

Figure 3.2: Communities Serviced by Surface and Groundwater Sources 3-2

Figure 3.3: Types of Surface Water Sources in the Province 3-3

Figure 3.4: THM Formation Potential Ranking of Surface Water Supplies in the Province 3-7

Figure 3.5: Chlorination Facilities throughout Newfoundland and Labrador 3-9

Figure 3.6: Status of THM Monitoring Program 3-17

Figure 4.1: Status of Source Water Quality Monitoring in the Province 4-2

Figure 4.2: Status of THM Samples 4-3

Figure 4.3: Status of THM Data 4-4

Figure 4.4: Status of THM Data with Seasonal Adequacy 4-5

Figure 4.5: Distribution of THM Levels in the Province 4-7

Figure 4.6: Ranking of Water Supplies with Seasonal Averages Above and Below 100 µg/L 4-9

Figure 4.7: Seasonal Variation of THM Values in (a) Heart’s Delight (b) Bonavista (c) Gander 4-13

Figure 4.8: Spatial Variation of THM Values in
Heart's Delight 4-15

Figure 4.9: Spatial Variation of THM Values in Bonavista 4-16

Figure 4.10: Spatial Variation of THM Values in Gander 4-17

List of Tables

Table 2.1: Disinfection Techniques	2-1
Table 2.2: Comparison of Disinfectants and Applications	2-3
Table 2.3: Forms of Chlorine Utilized in the Chlorination Process	2-2
Table 3.1: Land Use and Potential Pollutant Analysis Matrix	3-5
Table 3.2: Capital and Operational Costs of Chlorination Systems	3-9
Table 3.3: Conventional Water Treatment Plants in Newfoundland and Labrador	3-10
Table 3.4: Non-conventional Water Treatment Methods	3-12
Table 4.1: THM Results of Canadian Chlorinated Disinfection By-Products Survey by Health Canada (1995)	4-8
Table 4.2: Seasonal Dependence of THM Concentrations	4-8
Table 4.3: Communities and Associated Water Supplies with THM Concentrations Above 100 µg/L	4-19
Table 5.1: Combined Disinfectants and Their Applications	5-12